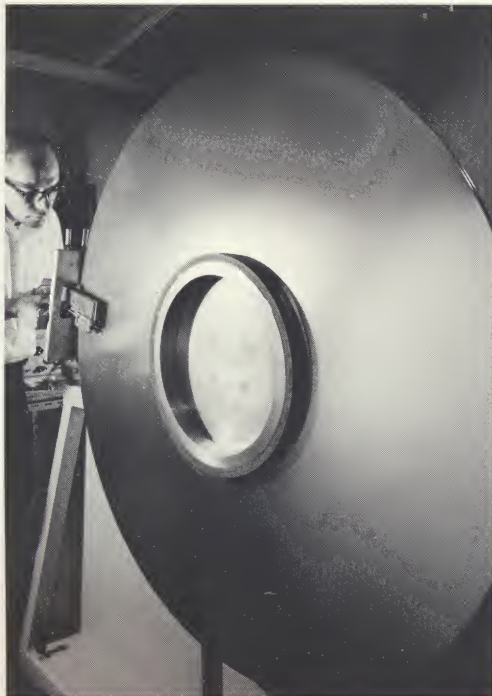


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major features and capabilities

- * The L-1500 can perform many of the functions of a central data processor; e.g., it eliminates table look-ups in the main memory for fixed addressing.
- * The L-1500 provides fast, flexible access to a massive data base.
- * Information is recorded and retrieved on the basis of search by record content without concern for physical location in the memory.
- * Search modes for making comparisons are: (1) equal to, (2) not equal to, (3) less than, (4) greater than, and (5) between upper and lower bounds—and any combinations of these. The memory can, at program option, be operated in fixed address mode, in content mode, or in a combination of read by content, write by fixed address.
- * All design factors are carefully conceived to assure highest reliability in real-time, on-line applications.
- * Average access time is only 35 milliseconds for read and less than 1 millisecond for write.

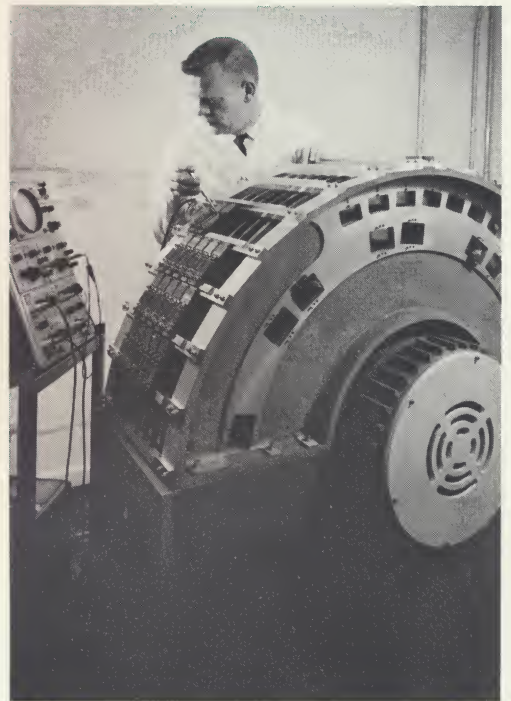


- * The L-1500 has dual-recording capability; at program option, highly sensitive data can be recorded on a "double-entry" basis to prevent any loss of critical information.
- * Its dual-motor drive gives the L-1500 fail-safe capability. If one motor slows or fails, the other cuts in to keep the disc file operating at full speed and full performance level.
- * A "master-slave" design concept assures great flexibility and expandability. Up to seven logic-sharing slave disc memories (each with six or fewer discs) can be added to each master disc memory to increase capacity with minimum cost. A present operating system, for example, can use seven masters each with seven slave units to provide storage of well over 10 billion bits.

Technician tests device (a read-write head) that records information on and withdraws information from the magnetic cobalt-coated surface of giant, 47.5-inch rotating memory disc shown here. A blown-up version of the disc portion of this photo appears on the cover. Memory systems containing two to six discs are available in L-1500 series.

general module description

2



The basic unit in the L-1500 series of disc files is a 47.5-inch-diameter, $\frac{1}{2}$ -inch-thick cobalt-plated disc with its associated complement of 512 nonmoving, fixed-position, "flying" magnetic heads. Packing densities of 420 or 840 bits per inch* result in 49,950 or 99,900 bits per track—more than 25.5 or 51 million bits per disc.

The multiple fixed-position flying heads contribute to both speed and reliability. Head-positioning mechanisms and positioning times are eliminated. Track selection is simply a matter of electronically selecting the required head(s). Access time therefore becomes only a function of disc latency—an average of 35 milliseconds and a maximum of 70 milliseconds for the smaller volume unit.

*Modified Ferranti mode of recording; use of NRZ would double the bit densities.

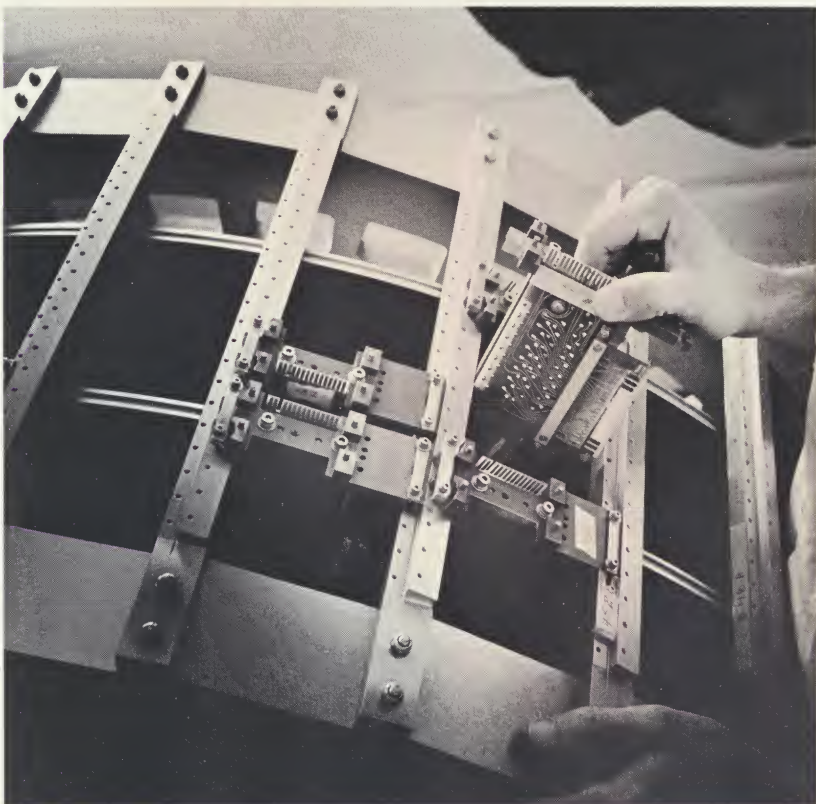
Technician adjusts reed pressure on head cartridge while monitoring read-back voltage on oscilloscope. Head records on and withdraws information from fast-spinning disc. Photo at right shows installation of read-write head cartridge on tie bar of Librascope-produced mass memory module. During operation, fixed-position flying heads ride on a film of air free of mechanical contact with discs.

A memory module consists basically of from two to six disc units stacked along a horizontal shaft that has an integral drive motor at each end. Both motors work to bring the discs to full rotational speed, thus reducing start-to-run time. A single motor then maintains the 900 or 450-rpm speeds, and a fail-safe feature cuts in the idle motor only if an unscheduled slowdown occurs in the on-duty motor.

The three basic disc file configurations are:

1. Model No. L-1510—the simple disc memory module with motors and heads.
 2. Model No. L-1520—a module additionally containing read/write amplifiers, head switching, and fixed-addressing electronics.
 3. Model No. L-1530—a module with all the features of Model Nos. L-1510 and L-1520 but which also includes power supplies and logic to permit this module to interface with slave disc modules and to be instructed to perform content search on stored data. The latter feature eliminates the need for fixed-address tables in the central data processor and results in store access times averaging less than 1 millisecond.
-

If specific data processors require custom interfaces, the basic three configurations can easily be varied in design; this capability has been anticipated and built into the present packages.



basic specifications

The following table gives specifications common to all disc file models, except for over-all size and weight. Additional specifications on Model No. L-1520 and Model No. L-1530 will be found in succeeding pages under the detailed descriptions of those more complex configurations.

Disc, Track, and Bit Data

Number of discs	2 to 6
Over-all disc diameter	47.5 in.
Recording diameter	37.8 to 47 in.
No. of tracks / radial inch	55
Track width	0.010 in.
Track center lines	0.018 in.
Track guard band	0.008 in.
Tracks per disc face	256
Bit packing densities	338 to 420 or 676 to 840 bits per inch (using modified Ferranti or phase-modulated mode of recording)
Bits per track	49,950 or 99,900
Track bit rate	Approx. 712,000 bits per sec.
Bits per disc	25.5 or 51 million
Maximum bit capacity, six-disc module	153 or 306 million
Disc recording surface	Proprietary electroless plated cobalt

Read/Write Heads*

Ferrite	0.010 in. wide
Coil	Center-tapped winding
Half-coil inductance	25 microhenries
Optimum write current	75 milliamperes
Gap width	0.0005 in.
Head-to-medium spacing	Contact start; 0.0001 in. running
Playback minimum	30 millivolts peak-to-peak using phase modulation at 840 bits/in.

Data Transfer Rate	356,000 characters per second, with optional feature of up to seven times that figure
--------------------	---

Drive System

Motor type	Dual, 900 or 450-rpm, integral-drive induction; (approx. 5% slip)
Power requirement	220v AC, 3-phase, 60-cycle, wye

*NOTE: Configurations other than standard head bars are available. Standard bars are made up of 16 heads, two common start and finish wires to all head coils, and 16 center-tap wires brought out to a printed-circuit connector. One variation combines those heads having common start and finish wires into a number of separate groups, thereby permitting simultaneous use of several heads in a block. Also available: read/write head combinations on the same track, with varying bit separations, for register purposes; these are useful for speed matching, buffering, or fast access loops. Heads can also be furnished for special clock or timing tracks.

Current draw (each motor) 50-amp starting; 9-amp running
Bearings Super-precision, preloaded,
angular contact ball bearings, life-
time lubricated; avg. life 25 yrs.

Physical Characteristics

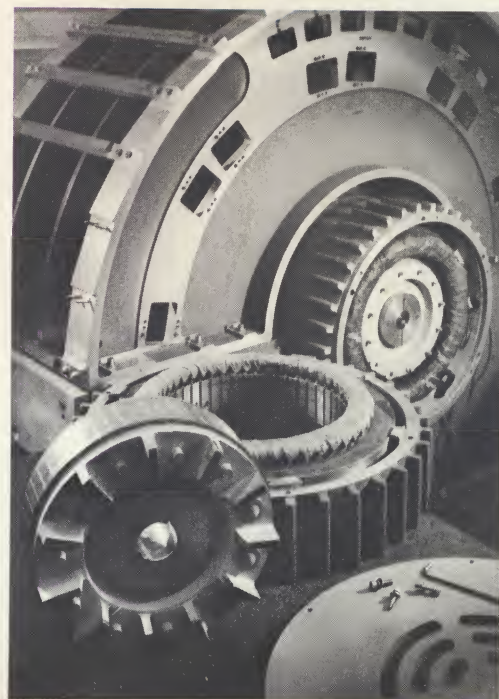
Over-all size of disc module
cabinet (without electronics) . . . 60 in. wide; 60 in. high; 36 in. deep
Weight (without electronics) . . . 1500 lb.
Cabinet construction Sheet metal with suitable service
access panels, louvered for effi-
cient air flow (if specified) or with
blower and heat exchanger for use
with external source of cool water
or as a closed refrigerated system

Operating Environmental Limitations

Ambient temperature 32° F to 125° F (recording and sub-
sequent reading possible over any
20° range within those limits)
Temperature gradient 15° F per hour
Dust control Operation in a standard air-
conditioned room with 20-micron
air filtration
Equipment supporting surface . . . Capable of supporting a concen-
trated load of 400 lb or a distributed
load of 150 lb per square foot; flat
and horizontal to within 2 degrees

In photo below three different types of magnetic head cartridges undergo continuity tests on coils to assure absence of open windings.

Photo at right shows disassembled dual-induction motor which drives mass memory disc file. One motor is mounted at each end of horizontal shaft along which two to six discs are stacked.



reliability

Typical Librascope reliability is inherent in the L-1500 series of fast-access mass-memory disc files. This high reliability stems principally from four factors: (1) a proprietary recording surface coating technique; (2) the efficient fixed-position, flying head design; (3) the method of recording; and (4) over-all basic design simplicity.

Magnetic Coating: Disc recording surfaces are plated with a magnetic cobalt coating, applied by a proprietary method developed over many years in Librascope research laboratories.

Long checkout has proved this coating to be extremely hard, damage-resistant, long-lived, and wear-resistant. In addition, the usual difficulties common with oxide-coated media—flaking, contamination, and drop-outs—are literally abolished. Because of these characteristics, multiple start-stop operations can be made without fear of damage or wear on the recording surfaces.

Flying Heads: During operation, the fixed-position flying heads ride on a film of air, free of mechanical contact with the discs. (Heads are in contact with discs only during start, acceleration, and shut-down.) Flexible head mounts automatically compensate for either variations in disc surfaces or temperature differentials. Bonded to the tip of each head is a self-lubricating material that cuts head and disc wear to a minimum and greatly reduces both initial drag and the break-away and accelerating torque. Unhampered by slow, complex head-positioning mechanisms, this read/write head technique provides the greatest possible speed, reliability, and service life.

Recording Method: The recording mode is the double-frequency, phase-modulated (or modified Ferranti) method, at densities of 420 or 840 bits per inch. Using this mode, Librascope laboratory tests have proved that the same disc coating and heads will actually operate reliably at more than 900 bits per inch—the equivalent of 1800 bits per inch in NRZ mode recording. The combination of a carefully shielded operating environment and a conservative packing density guarantees fault-free performance for long life periods.

If difficulty develops in a sophisticated data-processing memory system, it should be corrected at the earliest possible moment. Accordingly, protective signals and controls in the disc files alert the user soon enough to schedule maintenance or replacement without serious interruption of service.

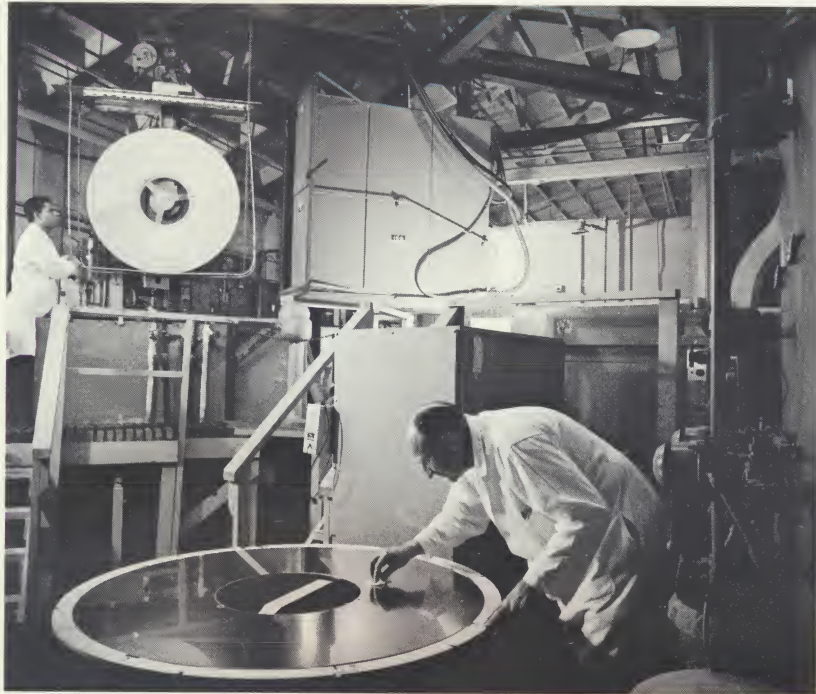
Disc shaft bearings and motor stators are constantly monitored for possible overheating. Excessive stator temperature or armature current on the running motor will automatically effect a switch of duty to the idle motor; a special detection circuit performs the same function if the running motor undergoes an unscheduled slowdown. Warning signals of those conditions, and of any excessive cabinet temperature, are displayed graphically on the module unit.

On-site maintenance of the Librascope L-1500 disc file is minimal.

6

automatic warnings/controls

maintenance



Each specially designed 32-track head cartridge (holding two blocks of 16 heads) is quickly and easily removed or installed. Physical connections are two bolts and a standard printed circuit card edge-type connector. Even the 16-track head bar, complete with its diode board, is replaceable on-site as a unit.

The special bearing system permits replacement of bearings with standard tools, without removing the disc frame from the cabinet and without loss of stored data.

Rotors and stators in the unique, integral twin-drive motor system can be replaced in a matter of minutes.

For field-level maintenance, standard tools may be used to service and maintain the L-1500 equipments.

In foreground of photo above, magnetic cobalt coating of disc surface is cleaned and inspected. Man at left prepares to insert disc blank into proprietary plating operation. In photo at right, disc blank is being lowered into solution tank to receive long-wearing, damage-resistant coating.



model no. L-1520 disc file

In addition to all the basic features embodied in Model No. L-1510 disc file, this configuration has read/write amplifiers, head switching, and fixed addressing electronics. Its circuits—like all Librascope disc file circuits—are solid-state and mount on 8¼-inch by 5-inch printed circuit cards. For this model, required voltages are —10v DC, +10v DC, —20v DC, and +20v DC.

Read/Write Amplifiers: To provide both phase discrimination between ones and zeros and the rejection of extraneous noise, the read amplifiers combine (1) the high common mode noise-rejection characteristics of a differential input and (2) a read strobe clock pulse-sampled output.

Read Amplifier (three circuits per card)

Input from head.....	Differential 25 millivolts peak-to-peak minimum
Common mode rejection.....	1 volt
Output.....	Logical level from flip-flop (0 to -10 volts)
Clocking.....	Read strobe clock input to permit data to be strobed into the output flip-flop; input can be jumpered if data is self-clocked
Inhibit.....	Inhibit signal input available to clamp the read amp flip-flop in one state
Band pass.....	50kc to 1 megacycle

Write Amplifier (three circuits per card)

Input from logic.....	Double-ended, with any required modulation or strobing done prior to input
Output.....	80 milliamperes to either side of head
Inhibit.....	Signal input permits inhibiting of writing even though selected head's center tap has +20 volts applied
Write check.....	Circuit constantly monitors write current in each side of the center-tapped magnetic heads; within one bit time, detects any failure of write amplifier circuit or write clock signals, or open heads, open selection diode, open selection driver

Selection Driver: When enabled by two conditioning input logic

levels ("AND"), these circuits (eight per card) apply +20 volts to the center taps of up to 18 read/write heads to implement reading or writing. In the entire selection process, the driver first selects a group of heads, then logic selects one or more read or write amplifiers in accordance with the "enable" signals.

Clock Cards: Various available clock cards receive input signals from a head on the major timing track and provide as outputs:

1. Major logical clock signal.
2. Read strobe signal for read amplifiers.
3. Write strobe signal for synchronizing write data.
4. Ferranti complement signals for phase-modulating write data.



Addressing: When the disc file is used in fixed-address mode, a required track or group of tracks is selected by the decoding of a specified track-select word presented to the console. A track data segment, or starting point, is also specified by a segment-select word presented to the console. The latter word is compared with a magnetically recorded fixed address track, which is read with a standard read amplifier and shifted into a register for comparison. This recorded fixed address carries a constantly checked parity bit. Two such registers keep the current and previous fixed addresses so that having the previous good fixed address, when a parity error in the current address is detected, allows programmed recovery.

Assembly line at Librascope Division where mass-memory disc file consoles are produced is shown above. In foreground are card cages which house logic elements for huge, random-access memory systems.

Rugged, sheet metal cabinet which encloses disc file modules is shown at right. Service access panels are louvered for efficient air flow (if specified). Cabinets may be equipped with blower and heat exchanger for use with external source of cool water.

Model No. L-1530 is a self-contained auxiliary memory console. Along with other equivalent consoles, it communicates directly by trunkline with the central processor.

Besides its own DC power supplies, maintenance panel, and heat exchanger (optional), the console contains magnetic disc storage, read/write heads, read and write amplifiers, head selection matrix, and the control and buffer registers and logic which enable the console to be instructed by the central processor. When certain main frame program-interrupt features are furnished, the console performs its instructed operation in parallel with main frame computation.

This master console also incorporates the interface logic for driving a trunkline accommodating up to seven slave disc files. Each slave

model no. L-1530 disc file



console contains only discs, heads, and read/write electronics—it shares the control logic of the master console.

The L-1500 type of memory system can be expanded modularly up to the limits dictated by central processor capability. Expansion is accomplished first by adding to each master console its full capacity of seven slaves, equivalent to 1.07 to 2.14 billion bits. The addition of up to six masters, each with seven slaves, can bring the system to a 56-console capacity of 8.6 to 17.2 billion bits, operating on a single trunkline from the central processor. Depending upon the particular central processor, more trunklines may be available—making eventual capacity virtually unlimited. In the case of the Librascope L-3055 central processor, for example, two trunklines are used to supply a total data storage capacity of 17.2 to 34.4 billion bits. Each master disc file console can be instructed by the central processor to perform a broad variety of operations:

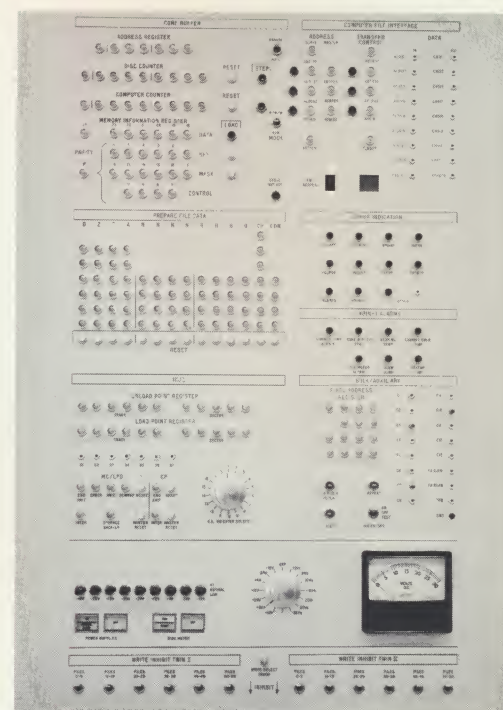
- * Read or write data by fixed address
- * Obsolete areas by fixed address
- * Read data by specified content
- * Obsolete data by specified content
- * Count data by specified content
- * Return contents of registers, counters, and error flip-flops for programmed error recovery

Fixed address features of the memory need rarely be used, since the disc file console registers can be loaded with search criteria permitting all combinations of greater than, less than, not equal, equal, and bounded by; and bit masking can be specified on individual bits of data. Data can be read by specified content; the associated disc area obsoleted; and rerecording can then be done as a random write—the disc memory placing the data in the first available obsolete position, with attendant access times of less than 1 millisecond.

Data research in the disc memory (of, for example, the Librascope L-3055 real-time data processor system) is in parallel with main frame computation.

Data transfer between main frame core memory and the disc memory console is interlaced with the main frame program core memory accesses. End of transfer at the disc console generates a main frame program interrupt, as does detection of any of several error types in the disc console.

Rotating discs in Librascope's mass memory disc file are contained in cabinets pictured on page 10. Removal of covers at left reveals logic and electronics sections of random-access memory system. L-1500 series is available in three different models to accommodate varied customer requirements. Control panel for mass memory assembly is shown on page 11 in close-up revealing banks of logic indicator lamps.



faster, more reliable memory system



12

Any automatic data processing operation will be faster, more accurate, more reliable, and have greater potential capacity with the L-1500 fast-access disc files than with any other type of mass memory. For more detailed information on these exceptional equipments, write, wire, or telephone:

Command and Logistics Systems Marketing

Librascope Division

Information Systems Group

General Precision, Inc.

808 Western Avenue, Glendale 1, California, Telephone: 245-8711

Most maintenance operations for L-1500 mass memory disc files may be accomplished with standard tools. Technician merely opens cabinet door to gain access to read-write heads for making final adjustment.

Model Nos. and Bit Capacities L-1500 Magnetic Disc File Series

Number of discs Model Nos. L-1514, L-1524, L-1534	2	3	4	5	6
Total bit capacity* (420 bits per inch)	51	76.5	102	127.5	153
Number of discs Model Nos. L-1518, L-1528, L-1538	2	3	4	5	6
Total bit capacity* (840 bits per inch)	102	153	204	255	306

*Millions of bits

Equipment Configurations for Model Nos. 1510, 1520, and 1530

	Model No. 1510	Model No. 1520	Model No. 1530
Disc Memory Module	X	X	X
Motors	X	X	X
Heads	X	X	X
Read/Write Amplifiers		X	X
Head Switching		X	X
Fixed Address Electronics		X	X
Power Supplies			X
Logic			X
Maintenance Panel			X

Formed early in 1963, the Information Systems Group of General Precision, Inc., joins the facilities and capabilities of Librascope Division, Commercial Computer Division, and a newly established Research and Systems Center into a single, unified entity. Located on the West Coast—the nation's major center of aerospace and electronics activity—ISG is organized to serve the rapidly expanding requirements of several important segments of the growing U.S. economy.

Librascope Division develops, produces, and markets a wide range of military and aerospace information processing systems, computers, controls, and components for application in the U.S. government and the nation's defense establishment. Responsibility for production, marketing, and installation of L-1500 disc files rests with this division of ISG.

Commercial Computer Division develops, produces, and markets electronic general-purpose computers, information-processing systems, components, and controls for application in science, business, and industry.

A well-balanced program conducted within the Research and Systems Center forms the basis for (1) determining ISG's new areas of interest, (2) utilizing advanced technologies, and (3) broadening systems efforts.

ISG activities are housed in modern, air-conditioned buildings covering 800,000 square feet of floor space. The group's payroll totals about 3000 people, with a high percent of technical, engineering, and scientific personnel.

Facilities and employees of ISG are supplemented by the nationwide resources of General Precision, Inc., a principal operating subsidiary of General Precision Equipment Corporation of Tarrytown, New York.

1500

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c c d n g p p e v e s n s d c n i
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